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13 ABSTRACT Describes a method for evaluation of recoilless rifle ammunition operational and functional performance characteristics. Identifies supporting tests, facilities, and equipment required. Provides procedures for preoperational inspection, physical characteristics, safety, personnel training, accuracy, dispersion, security from detection, adverse conditions, user reaction, portability, transportability, functioning, reliability, maintenance, human factors, and value analysis. Excludes ammunition lethality.		

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U. S. ARMY TEST AND EVALUATION COMMAND
EXPANDED SERVICE TEST - SYSTEM TEST OPERATIONS PROCEDURE

AMSTE-RP-702-109

Test Operations Procedure 4-3-013

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AMMUNITION, RECOILLESS RIFLE

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SECTION I
GENERAL

1. Purpose and Scope.

- a. This Test Operations Procedure (TOP) is offered as a guide to assist in the preparation of a test plan to support the Expanded Service Test (EST) of recoilless rifle ammunition. It describes methods and techniques to be used in determining if a type recoilless rifle ammunition meets criteria established in requirements documents and is suitable for use by the U.S. Army.

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b. These procedures cover (1) preoperational considerations of characteristics, safety, and personnel training, (2) a series of evaluating tests in functional areas, and (3) an examination of human factors engineering and value analysis. Ammunition lethality, a responsibility of other testing, is not addressed here.

2. Background.

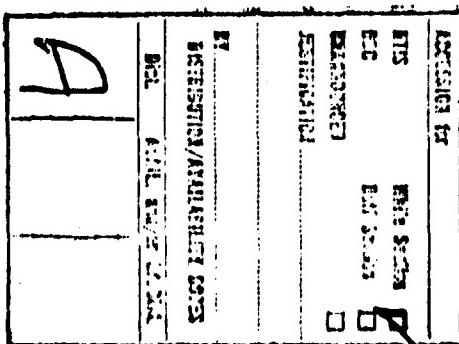
a. In a configuration dictated by the principles which make the weapon truly recoilless, ammunition used to support the family of recoilless rifles is a complete and fixed cartridge. It is especially designed with openings in the case to allow combustive gases to escape to the rear of the weapon in just the right amounts to counteract normal recoil. Each round consists of a projectile tailored to the fire mission, a cartridge case of steel or aluminum, a propellant, and a percussion-type primer. To date, recoilless rifle ammunition has been produced in 57-mm, 75-mm, 90-mm, 105-mm, 106-mm, and an experimental 120-mm size.

b. Although the technical tests associated with munitions is a function of other agencies, expanded service testing can perform the important role of comparing new ammunition to expressed criteria, and determining its merits when tested in the hands of the infantry soldier.

3. Equipment and Facilities.

a. Equipment.

- (1) Test items.
 - (2) Control items.
 - (3) Binoculars.
 - (4) Stopwatches.
 - (5) Weighing equipment.
 - (6) Linear measuring equipment.
 - (7) Vehicles, air and ground.
 - (8) Photographic equipment.



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- (9) Meteorological equipment.
 - (10) Communications equipment.
 - (11) Safety and first aid equipment.
 - (12) TOE Infantry recoilless rifle unit.
 - (13) Other equipment prescribed in referenced MTP/TOP.
- b. Facilities.
- (1) Firing ranges (Instrumented where possible).
 - (2) Ammunition storage area.
 - (3) Office, classroom, and storage space.

SECTION II TEST PROCEDURES

4. Supporting Tests.

a. The procedures outlined in this document provide general guidance to the test officer for the expanded service testing of a type recoilless rifle ammunition. The tests should be applied selectively according to the mission and criteria expressed for the test item. Specific procedures will depend on characteristics of the test ammunition and the stated requirements of applicable materiel needs documents.

b. Although the subtests are described in successive paragraphs, they need not be conducted in the order presented. Some will overlap or be performed simultaneously with others.

c. The establishment of adequate sample sizes is one of the most difficult problems encountered in the testing of ammunition, particularly since most of the tests are destructive and the test items stem from a limited amount of development samples. Maximum use of statistical techniques should be made to assure the sample sizes will be adequate to support conclusions as to the suitability of the test item. When requirements cite reliability criteria and confidence levels, sample sizes should be computed to ensure that such levels are met. If the number of samples available is not sufficient to meet the stated requirements, the test plan must

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indicate the confidence level attainable with the available samples. A statement should be included in the test officer's findings to show the number of samples required to meet the stated requirements. Guidance in selecting samples for desired confidence levels is contained in MTP/TOP 3-1-002, Confidence Intervals and Sample Size. To ensure a correct interpretation of a complex reliability statement, the test officer should consult with a statistician. The statistician should also help plan the overall experimental design or pattern of the test.

d. Data should be collected in sufficient quantities to support valid conclusions. This objective may be constrained by a limited quantity of test or control items, a limited time frame to accomplish the test, or limits on manpower, funds, or general support facilities. To identify the best means of securing meaningful data within the limitations imposed, the test officer must maintain close liaison with statistical personnel.

e. A log book should be maintained as a chronological record of observations, remarks, meteorological data, times, comparisons, other pertinent events, and results by individual cartridge. An orderly and accurate tabulation will expedite the essential collation process subsequent to each test. Photographs, motion pictures, and/or charts and graphs are recommended as narrative supplements where appropriate.

f. Common MTP/TOP, the tests defined in Section III, and other publications to be considered in formulating an EST plan are listed in the reference appendix and as follows:

<u>TEST SUBJECT TITLE</u>	<u>PUBLICATION NO.</u>
(1) Preoperational Inspection and Physical Characteristics (refer to para 5)	
(2) Safety (refer to para 6)	4-3-514
(3) Personnel Training (refer to para 7)	4-3-501
(4) Accuracy and Dispersion (refer to para 8)	3-3-507, 3-3-512, 3-3-513 4-3-104, 4-3-119

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	<u>TEST SUBJECT TITLE</u>	<u>PUBLICATION NO.</u>
(5)	Security from Detection (refer to para 9)	1-3-515
(6)	Adverse Conditions (refer to para 10)	4-3-506
(7)	User Reaction (refer to para 11)	4-3-504
(8)	Portability/Transportability (refer to para 12)	4-3-503 and 4-3-511
(9)	Functioning and Reliability (refer to para 13)	4-3-502
(10)	Maintenance (refer to para 14)	4-3-513
(11)	Human Factors Engineering (refer to para 15)	4-3-515
(12)	Value Analysis (refer to para 16)	

SECTION III
SUPPLEMENTARY INSTRUCTIONS

5. Preoperational Inspection and Physical Characteristics.

a. Objectives.

The objectives of this subtest are to verify the completeness of the ammunition received for testing and to compare its physical characteristics with the stated criteria of needs documents. A further objective is to determine if each item received is in a serviceable condition and suitable for testing.

b. Method.

(1) The test personnel who participate in this phase of testing must have been thoroughly trained in the handling of munitions. They should be aware of the safety aspects of handling the test item in its crated configuration, during the unpacking processes, and while examining.

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(2) In obtaining data to support test findings, it is important to isolate the when and where of events during the process of arriving at a determination of what happened. It is possible that a failure attributed to expanded service testing may actually have been a by-product of poor shipping practices or improper handling of the item prior to its arrival at the test site. To assure accurate reporting, pretest conditions of damage, deterioration, or defects in the manufacturing processes must be discovered and recorded during this phase.

(3) Competent personnel should begin the preoperational inspection with an examination of the test ammunition in its shipping containers. The following should be recorded:

- (a) Type of container.
- (b) Evidence of damage or deterioration to the shipment.
- (c) Means and condition of materials used to secure and protect the shipment.
- (d) Any external evidence of spillage or damage.
- (e) Identification markings to include: type, model, lot number, name of contractor, the contract date and number, and date of manufacture.

(4) A representative number of containers should be opened and the individual rounds examined for damaged or incomplete cartridges, evidence of corrosion, dirt, or visual evidence of anomalies.

(5) The physical characteristics of the test ammunition should be checked against stated criteria. The test ammunition, components, and packaging should be weighed and measured.

(6) MTP/TOP 4-3-041, Cartridge Cases, will assist in determining the suitability of the cartridge cases for use in subsequent testing.

c. Data Required.

(1) A record and photograph of all evidence of damage, deterioration, and insufficient identification.

(2) A comparison of all weights and measurements with those found in any technical manuals or pamphlets accompanying the test item.

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(3) A comparison of the results of inspection and checks with the criteria established in materiel needs documents.

(4) Test item characteristics should be compared with those of the control items.

d. Analytical Plan.

An appropriate narrative report of significant findings should be prepared; and supported with pictorial evidence as appropriate.

6. Safety.

a. The applicable procedures of MTP/TOP 4-3-514, Safety Hazards, should be performed to determine the effectiveness of the safety features, and to confirm the safety of each component of the ammunition received for testing.

b. During this phase, the test officer should identify any restrictions imposed by the safety release, directives, or local rulings which might influence the test results. When safety considerations, in the opinion of the test authority, do influence the results in any area, this factor will be reflected in appropriate reports.

7. Personnel Training.

a. The applicable procedures of MTP/TCP 4-3-501, Personnel Training, should be performed to determine (1) the type and amount of training required for personnel to learn to store, transport, handle, prepare, and fire the test ammunition efficiently, (2) whether the proposed program of instruction is adequate, and (3) whether the test item meets the training criteria expressed in requirements documents.

b. During this period of training all test personnel should become thoroughly familiar with:

(1) The characteristics of the test ammunition.

(2) The conduct, procedures, and objectives of the expanded service test.

(3) Individual assignments and responsibilities.

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c. To enhance validity during the tests, it is essential that test personnel become equally familiar with the test ammunition and control item. It is important that the performance of the test item not be degraded because of its newness or unfamiliarity. If personnel are familiar with the control item, emphasis will be placed on the test item training to overcome bias.

d. If a program of instruction accompanies the test ammunition, it should be evaluated for adequacy, its shortcomings noted, and any recommendations for improvement made a matter of record.

8. Accuracy and Dispersion.

a. The applicable procedures of firing exercises outlined in appropriate MTP/TOP should be performed to determine the test ammunition's accuracy performance.

b. The following MTP/TOPs contain appropriate procedures, exercises, and data collection guidance to support this subtest:

(1) 3-3-507, Tracking and Hitting Performance, Stationary Gun-Moving Target.

(2) 3-3-512, Round-to-Round Dispersion.

(3) 3-3-513, First and Subsequent Round Hitting.

(4) 4-3-104, Projectile, Antipersonnel/Antimateriel.

(5) 4-3-119, Projectile, "Beehive".

c. The first three procedures listed above address the recoilless rifle in its antitank role when fired at vertical targets. The last two are designed to offer a horizontal target configuration to evaluate the anti-personnel/antimateriel capability of the weapon and its ammunition. Depending upon the availability of ammunition, all or a representative number of the exercises should be fired.

d. Maximum value will be received if the test ammunition is compared with a control item during the conduct of the selected firing exercises. Each round of test and control ammunition should be exposed to the same conditions of weather, handling, crew, marksmanship ability, and other circumstance which could affect its performance.

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9. Security from Detection.

a. The applicable procedures of TOP 1-3-515, Security from Detection (Infantry Weapons, Munitions, Equipment, and Accouterments), should be performed to determine the signature effects of the test ammunition.

b. The back-blast of the present recoilless rifle is decidedly detrimental to position security, and the possibility of improvement in this area makes a test of signature effects of prime importance in evaluating future models. TOP 1-3-515 outlines methods of evaluating position disclosing effects of firing under the varying conditions of daylight and darkness, and from covered and uncovered emplacements. Appropriate data can be obtained by firing both test and control items and observing, filming, and/or photographing the activity from various angles.

10. Adverse Conditions.

a. The applicable procedures of MTP/TOP 4-3-506, Adverse Conditions, should be performed to determine to what degree the test ammunition will be affected by unusual or non-standard conditions.

b. Engineering tests should provide the principle data related to the pure reaction of explosives or munitions to such foreign matter as mud, sand, moisture, frost, snow, ice, dirt, oil, and grease. Beyond the sphere of the engineering tests lies the area of the abnormal encountered by troops in the field. This phase of expanded service testing should deal with such effects as temperature changes, preparation of cartridges for firing during night operations, and the preparation of the ammunition while wearing cold weather gloves and other specialized clothing and equipment.

11. User Reaction.

a. The appropriate procedures of MTP/TOP 4-3-504, User Reaction, should be used to determine any effects the test recoilless ammunition might have on soldiers required to use it.

b. The effectiveness of any weapon or its ammunition is influenced by the reaction of its users in areas of compatibility with comfort, ease of operation, and psychological impact. Each new ammunition or ammunition component creates actions that cause direct or indirect user reaction. MTP/TOP 4-3-504 examines crew reaction and effects upon the area immediately surrounding the firing location of new ammunition.

12. Portability/Transportability.

a. The applicable procedures of MTP/TOP 4-3-503, Battlefield Mobility (Battlefield Mobility, Tactical Flexibility and Portability) (Munitions), and MTP/TOP 4-3-511, Transportability (Ammunition) should be conducted to determine the ability of the test ammunition to withstand handling and transport without damage.

b. The procedures referenced above contain ample and appropriate tests of both portability and transportability under the varying conditions of a simulated combat environment. The test ammunition and the control item should be compared in exercises examining hand carry, rail movement, vehicular and rail transport, and air movement to include air drop.

13. Functioning and Reliability.

a. The applicable procedures of MTP/TOP 4-3-502, Ammunition Functioning and Reliability, should be followed to obtain methods for observing and recording the functioning of the test ammunition, and to determine its overall reliability in relationship to materiel needs requirements.

b. Throughout the course of other subtests, duds, misfires, short rounds, erratic flight, or damages initiated by normal handling should be reported and properly recorded.

14. Maintenance.

a. The applicable procedures of MTP/TOP 4-3-513, Maintenance, should be conducted to determine if the ammunition under test meets the criteria for maintenance and maintainability established in the appropriate materiel needs requirement documents.

b. Ammunition maintenance will consist mainly of frequent observations and special visual examinations designed to detect damage or deterioration of any sort to the recoilless cartridge or its packaging. Realizing that ammunition passes through a series of handling, transporting, and storing phases before reaching the firing position (each of which may contribute to deteriorating its factory condition), maximum effort must be made to detect anything making the round unsafe or less than visually perfect. Using units are not authorized any ammunition maintenance beyond visual inspection, cleaning, and those minor corrective measures prescribed in specific directives. Safety is paramount, and all test personnel must be thoroughly familiar with the extent of maintenance authorized at user level.

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15. Human Factors Engineering.

a. The procedures of MTP/TOP 4-3-515, Human Factors Engineering, should be performed to evaluate the degree to which human factors considerations were built into the design of the recoilless ammunition being tested.

b. In theory, ammunition, as well as other items used or worn by a soldier, should be designed and developed within the confines of scientific principles concerning human physical and psychological characteristics to increase speed and precision of operation, provide maximum efficiency, reduce fatigue, and simplify operations. The procedures of MTP/TOP 4-3-515 outline methods of collecting pertinent data during the conduct of other test phases which can aid the test officer in forming a judgment in this area.

c. When available, human factors personnel should be consulted prior to the beginning of expanded service testing for assistance in the development of questionnaire, interview techniques, and preparation of human factor entries in plans and reports.

16. Value Analysis.

a. Objective.

This phase of testing should determine if the test ammunition packaging has any costly or superfluous features which might be eliminated or modified without interfering with the safety or functioning of the item.

b. Method.

A cost-consciousness orientation should alert test personnel to note and report anything connected with the ammunition containers which appears nice-to-have but is unnecessary.

c. Data Required.

The recorded comments and observations of test participants as related to value analysis supported by pictures, where applicable.

d. Analytical Plan.

An analysis of the information received should be prepared and collated, and the resulting narrative supported with pictures, charts, or graphs, as appropriate.

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APPENDIX
REFERENCES

1. AR 70-10, Research and Development, Test and Evaluation During Development and Acquisition of Materiel.
2. TECOM Reg 70-24, Documenting Test Plans and Reports.
3. TECOM Reg 70-34, Risk Analysis for Suitability Tests.
4. TECOM Reg 386-6, Verification of Safety of Materiel During Testing.
5. TECOM Reg 750-15, Maintenance Evaluation During Testing.
6. FM 23-11, 90-mm Recoilless Rifle M40A1.
7. FM 23-82, 106-mm Recoilless Rifle M67.
8. MTP/TOP 1-1-012, Classification of Deficiencies and Shortcomings.
9. MTP/TOP 3-1-002, Confidence Intervals and Sample Size.
10. MTP/TOP 4-2-013, Recoilless Rifle Ammunition.
11. MTP/TOP 4-3-041, Cartridge Cases.